

COMPARISON OF MID-INSTAR NYMPHS OF
PERIPLANETA FULIGINOSA (SERVILLE) AND
PERIPLANETA AMERICANA (L.) (BLATTODEA: BLATTIDAE)

JILL M. GORDON

Department of Entomology, Clemson University, Clemson, South Carolina 29634-0365.

Abstract.—Mid-instar nymphs of two *Periplaneta* species are described and compared. Although middle to late stage nymphs of *Periplaneta fuliginosa* (Serville) and *Periplaneta americana* (L.) are difficult to distinguish from each other, two key characters (spines on the prothoracic femur and teeth on the left mandible) are described and drawn which allow for separation of the species.

Key Words: Prothoracic legs, mandibles, diagnosis

Two *Periplaneta* species, the smoky-brown cockroach, *P. fuliginosa* (Serville), and the American cockroach *P. americana* (L.), are considered to be major pest species in the southeastern United States (Appel and Rust 1987). Since there are differences in behavior and habitat preference between the two species (Schal et al. 1984), correct identification of the two species is important. The adults are easily distinguished by color patterns (see adult description in this paper). However, the middle and late instar nymphs are very similar and there are no existing accurate keys for discrimination of these developmental stages.

Because of morphological differences between early and late instar nymphs of the two species, keys should specify which stage of development is being identified. However, stage of development has not been provided consistently in the existing literature. Hebard (1917) described briefly the nymphs of *P. americana*, *P. fuliginosa* and *P. australasiae* (F.) but did not differentiate between early and late instars. Sweetman (1965) also provided key characters for early instar nymphs of *P. americana*, *P. aus-*

traliasae, *P. fuliginosa* and *P. brunnea*. Powell and Robinson (1980) presented one of the first thorough descriptions and keys to identify first instar nymphs of five *Periplaneta* species. They also reported that when Burmeister (1838) established the genus *Periplaneta*, he misidentified a nymph of *P. americana* as *P. brunnea*.

The following comparison between these two species includes an adult diagnosis, a diagnosis of the mid-instar nymphs, a detailed description of the mid-instar nymphs, the known distribution of the species, and biological notes on each species. Figures are included where differences need to be elucidated.

MATERIALS AND METHODS

Specimens for this study were obtained from laboratory colonies maintained at the Clemson University Urban Entomology Laboratory. Six unhatched oothecae of *P. americana* and *P. fuliginosa* (three of each) were removed from laboratory rearing containers and placed individually in petri dishes and checked daily. Once the oothecae hatched, the nymphs from each ootheca were

placed in a quart Ball® jar containing a screen, a water vial with a sponge plug and dog food. When the nymphs reached a length of approximately 120–130 μ (=15–18 mm) they were identified as middle instar nymphs after a classification by Appel and Rust (1986) and were placed in a freezer and held for examination.

Ten specimens each of *P. fuliginosa* and *P. americana* were examined at 40 \times under a dissecting microscope fitted with an ocular micrometer. The conversion factor for the micrometer is eight microns in one millimeter. For consistency, measurements will be reported in this paper in microns. Observations were made first on the whole insect body, then exploratory dissections were conducted on legs, abdominal segments, thoracic segments, head and mouthparts. Drawings were made of anatomical parts where a difference between the two species was conspicuous. Voucher specimens are deposited in the Clemson University Arthropod Collection.

DISCUSSION

Periplaneta americana (Linnaeus)

Adult.—Color above chestnut brown; tegmina unicolorous; last segment of male and female cercus twice as long as wide; male abdominal segment I unmodified; male supraanal plate translucent, apically rounded and deeply notched, produced considerably beyond the subgenital plate (Powell and Robinson 1980).

Mid-instar nymph (N = 10).—Head dark brown to black on vertex and frons fading to reddish brown on clypeus. Antennae as long as body, dark brown basally to light red brown apically. Mandibles darker in color on dents (mesal margins), left man-

dible with seven dents (Fig. 1), right mandible with five. Palps light brown and white on each segment, labial palps white apically, maxillary palps reddish brown apically.

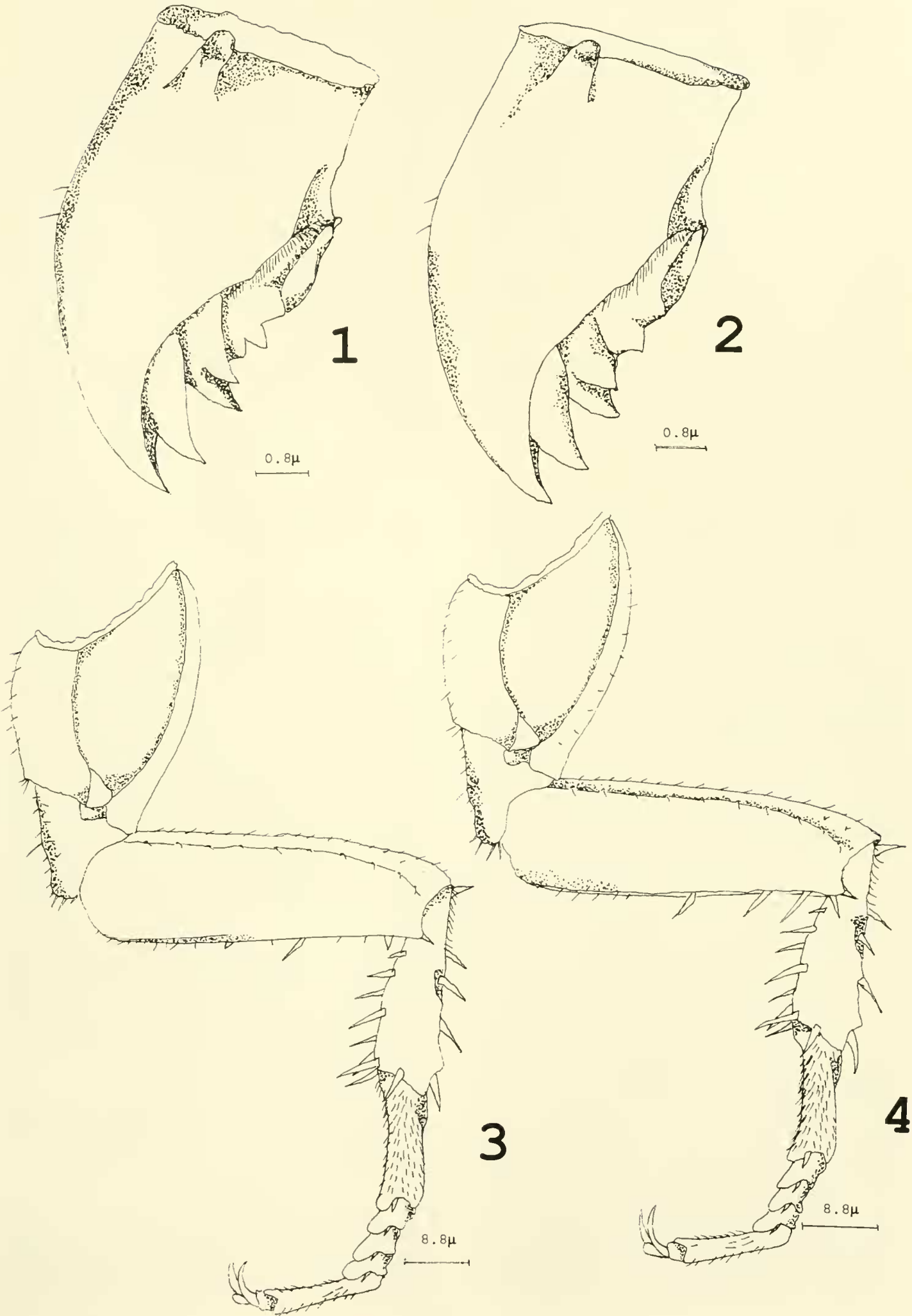
Pronotum: Length 38 μ ($\pm 8 \mu$), width 52 μ ($\pm 8 \mu$), ratio 0.73, sparsely setose with very short setae. *Mesonotum*: length 22 μ ($\pm 5 \mu$), width 58 μ ($\pm 5 \mu$), ratio 0.37. *Metanotum*: length 18 μ ($\pm 3 \mu$), width 58 μ ($\pm 3 \mu$), ratio 0.31. Thoracic nota variable in color, usually with pronotum reddish brown with pale brownish white markings on lateral margins and dark anterior and posterior margins. Mesonotum and metanotum uniformly reddish brown.

Abdominal terga reddish brown anteriorly, changing to dark brown posteriorly, sparsely setose with very short setae. Segments I–III white ventrally, segments IV–VIII reddish brown ventrally with dark brown on lateral margins. Segments IV–VIII each 10 μ ($\pm 6 \mu$) long, and, IV to VIII, respectively, 52 μ ($\pm 4 \mu$), 55 μ ($\pm 3 \mu$), 55 μ ($\pm 3 \mu$), 55 μ ($\pm 3 \mu$), 50 μ ($\pm 2 \mu$), wide.

Legs light reddish brown ventrally. Coxa dark brown anteriorly and white posteriorly with small scattered setae. Femur 40 μ ($\pm 5 \mu$) long, one long and three short spines on anteroventral margin. Fifteen long spines on posteroventral margin. Tibia 20 μ ($\pm 5 \mu$) long, with 15 large (9 μ long) spines radially, tibia and tarsus covered with setae. Tarsal segments = 5,5,5, spurs at apex of each tarsomere 1–4, no spurs on tarsomere 5, two tarsal claws present with arolium (5 μ long) (Fig. 3). Cerci reddish brown, densely setose ventrally.

Known distribution.—Africa, Europe, India, Japan, Australia, North America, South America (Bell and Adiyodi 1982).

Biological notes.—*Periplaneta ameri-*



cana prefers a warm, moist environment. The upper limit of preferred temperatures is 33°C. In tropical and subtropical America, this cockroach is common outdoors and seen most frequently in the summer months, however they do remain active at 21°C. Evidence points to their origin being tropical Africa (Cornwell 1968). The American cockroach is an indoor/outdoor pest of human structures, feeding on decaying organic matter, debris and almost any available substrate. They are found in leaf litter, shrubbery, and in most lower levels of structures which provide adequate moisture. There are 9–12 nymphal molts and a life-span of two years (Cornwell 1968).

Periplaneta fuliginosa (Serville)

Adult.—Color above entirely blackish brown; both sexes fully winged; male abdominal segment I with broad shallow depression bearing tuft of setae; male supraanal plate sclerotized, opaque, apically truncate and not deeply notched, not or scarcely produced beyond the subgenital plate; ventral surface of male supraanal plate specialized bearing two large callosities, the surfaces of which are covered with microscopic denticulations (Powell and Robinson 1980).

Mid-instar nymph (N = 10).—Head reddish brown dorsally and ventrally. Palps brown and white alternatively; maxillary palps reddish brown apically, $24\ \mu$ ($\pm 6\ \mu$) long, labial palps white apically, $10\ \mu$ ($\pm 4\ \mu$) long. Left mandible with six teeth on mesal surface (Fig. 2), right mandible with five teeth on mesal surface. Antennae as long as body; uniformly reddish brown, each segment showing band of pale brown apically.

Thoracic nota reddish brown with dark brown on posterior edges. Pronotum: length $40\ \mu$ ($\pm 8\ \mu$), width $55\ \mu$ ($\pm 8\ \mu$), ratio 0.72 covering $\frac{2}{3}$ of head. Mesonotum: length $11\ \mu$ ($\pm 5\ \mu$), width $70\ \mu$ ($\pm 5\ \mu$), ratio 0.31. Metanotum: length $22\ \mu$ ($\pm 5\ \mu$), width $70\ \mu$ ($\pm 5\ \mu$), ratio 0.31. All thoracic nota sparsely setose with short setae.

Abdominal terga reddish brown with dark brown on posterior edges, sparsely setose, segments IV–VIII $10\ \mu$ ($\pm 4\ \mu$) long and segments IV to VIII, respectively, $62\ \mu$ ($\pm 4\ \mu$), $65\ \mu$ ($\pm 2\ \mu$), $68\ \mu$ ($\pm 2\ \mu$), $68\ \mu$ ($\pm 2\ \mu$), and $55\ \mu$ ($\pm 4\ \mu$) wide. Segments I–III white ventrally, segments IV–VIII reddish brown ventrally.

Legs reddish brown. Coxa with small scattered setae. Femur $40\ \mu$ ($\pm 5\ \mu$) long, five spines of even length on anteroventral margin, 15 long spines on posteroventral margin. Tibia $20\ \mu$ ($\pm 5\ \mu$) long, with 15 large ($9\ \mu$ long) spines radially, tibia and tarsus covered with setae. Tarsal segments = 5,5,5, spurs at apex of each tarsomere 1–4, no spurs on tarsomere 5, two tarsal claws present with arolium ($5\ \mu$ long) (Fig. 4). Cerci reddish brown, densely setose ventrally.

Known distribution.—Japan, China, North America, South America (Schal et al. 1984).

Biological notes.—*Periplaneta fuliginosa* also prefers warm moist habitats and has a biology which is similar in some respects to *P. americana*. *P. fuliginosa* is a domiciliary pest found most commonly in the southern United States. It infests structures as well as harboring in leaf litter, shrubbery, mulch and especially in the upper branches of large hardwoods. For this reason it is commonly found in attics and upper levels of structures which it enters through the roof or attic windows (Cornwell 1968). Unlike *P. americana*, the nymphal development of *P. fuliginosa* is not affected as much by temperature as by the proximity of other nymphs. *P. fuliginosa* has approximately 9–12 nymphal molts and a life span of two years (Guthrie and Tindall 1968).

For a comparison of diagnostic characteristics between the mid-instar nymphs of the two *Periplaneta* species, see Table 1.

SUMMARY

Ten mid-instar nymphs of *P. americana* and *P. fuliginosa* were dissected and examined under the microscope. In a textbook

Table 1. Diagnosis of mid-instar nymphs of *Periplaneta* spp.

<i>P. americana</i> (L.)	<i>P. fuliginosa</i> (Serville)
Left mandible with seven dents (Fig. 1)	Left mandible with six dents (Fig. 2)
Prothoracic femur with four small spines of varying length on anteroventral margin (Fig. 3)	Prothoracic femur with five subequal spine (c. 5) on anteroventral margin (Fig. 4)
Antennae dark brown basally, pale red apically	Antennae unicolorous reddish brown
Head dark brown to black on vertex and frons, reddish brown on clypeus	Head unicolorous reddish brown
Pronotum variable, often reddish brown with pale lateral margins and dark brown anterior and posterior margins; otherwise, thoracic nota pale reddish brown, white ventrally	Thorax reddish brown dorsally, white ventrally
Abdominal terga light brown anteriorly, shading to dark reddish brown posteriorly; sterna pale reddish brown	Abdominal terga reddish brown with darker margins posteriorly; sterna pale reddish brown

by Stehr (1987), these two species are separated by the presence (*P. fuliginosa*) or absence (*P. americana*) of an arolium. Of the 20 specimens examined in both species the arolia were always present. Many other characteristics used to separate the two species are highly variable, such as color and size. Two consistent diagnostic characters were identified which are easily seen using a common dissecting microscope at 40×. These characters were also found in some of the smaller instars (although they become difficult to see with smaller sizes) and larger instars through adults. Seven distinct teeth are present in the left mandible of *P. americana* and only six teeth in the left mandible of *P. fuliginosa* (Figs. 1, 2). The prothoracic legs of *P. americana* have only one long and three short spines along the lateral posterior margin of the femur while the same area of *P. fuliginosa* has five long spines (Figs. 3, 4).

The characters described above would be useful in the field identification of the two *Periplaneta* species if a good hand lens were used. In the laboratory, these characters could be used for separating nymphs of the two *Periplaneta* species with the aid of a dissecting microscope. Continued research on differences between the more frequently

confused *Periplaneta* cockroach species should provide more information for differentiating both nymphs and adults of these species in the future.

ACKNOWLEDGMENTS

I would like to thank Dr. John Morse of Clemson University for helpful suggestions during this research and for patient editing assistance. I would also like to thank Dr. Pat Zungoli for her time in reading and editing this manuscript. This is Contribution No. 3156 of the South Carolina Agricultural Experiment Station, Clemson University.

LITERATURE CITED

Appel, A. G. and M. K. Rust. 1986. Time-activity budgets and spatial distribution patterns of the smokybrown cockroach, *Periplaneta fuliginosa* (Dictyoptera: Blattidae). *Annals of the Entomological Society of America* 79: 104-108.

———. 1987. A bibliography of the smokybrown cockroach (Dictyoptera: Blattidae) an urban and suburban pest. *Journal of Entomological Science* 22: 175-187.

Bell, W. J. and K. G. Adiyodi. 1982. *The American Cockroach*. Chapman and Hall, London, New York.

Burmeister, H. 1938. *Handbuch der Entomologie*. Band 2, Abteil 2, pp. 459-756. Berlin.

Cornwell, P. B. 1968. *The Cockroach*, Vol. I. Hutchinson of London. 392 pp.

- Guthrie, D. M. and A. R. Tindall. 1968. The Biology of the Cockroach. St. Martins Press, New York.
- Hebard, M. 1917. The Blattidae of North America, north of the Mexican boundary. Memoirs of the American Entomology Society 2: 1-284.
- Powell, P. and W. H. Robinson. 1980. Descriptions and keys to the first instar nymphs of five *Periplaneta* species (Dictyoptera: Blattidae). Proceedings of the Entomological Society of Washington 82: 212-228.
- Schal, C., J. Gautier, and W. J. Bell. 1984. Behavioural ecology of cockroaches. Biological Review 59: 209-254.
- Stehr, F. W. 1987. Immature Insects. Kendall/Hunt Publishing Co., Dubuque, Iowa. 754 pp.
- Sweetman, H. L. 1965. Recognition of Structural Pests and their Damage. Wm. C. Brown Co., Dubuque, Iowa. 371 pp.